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Mix Design Steps for Self-Compacting Concrete

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Abstract – *The Self-Compacting Concrete is a futuristic product in civil engineering field. This product helps to the civil engineers to overcome in the issue of workmanship. The preliminary step is mix design procedure for Self-Compacting Concrete is different as steps adopted for normal concrete mix and it is carried out by using Indian standard 10262-2008 but self-compacting concrete is based on EUROPEAN specification and guidelines given in „EFNARC 2002". This paper presented by taking one detailed mix design example of Self-Compacting Concrete and it includes detailed steps are as listed: Mix Design Procedure, Specification and guidelines, Frame work, Calculation of Materials and Mix Proportions.*

***Key Words*: Specification and guidelines, Frame work, Mix Design Procedure, Mix Proportion**

1. INTRODUCTION

The mix design procedure for self-compacting concrete is different as steps adopted for normal concrete mix and it is based in Indian standard 10262-2008, but self-compacting concrete is based on EUROPEAN specification and guidelines given in „EFNARC 2002". Following are the steps adopted in self-compacting concrete.

1.1 Mix Design Procedure

The above mix design procedure gives the clear picture about the powder content, selection of materials both inert or filler and chemically reactive for producing good concrete, adjustment of materials by making trail mixes and checking performance for each mix

1.2 EFNARC 2002 Specification and guidelines:

a) Fix Air Content
b) Coarse aggregate volume is calculated and it is less in quantity.
c) Fine aggregate volume is determined it is up to 50% by the volume of paste content.
d) Paste composition is calculated.
e) Water: powder ratio and superplasticizer dosage is fixed.
f) Standard tests are conducted for Checking of concrete properties.

2. Frame work of Self-compacting concrete:

Frame work of SCC is the requirement of quantity as per EFNARC 2002. Initial requirement for SCC is Total Powder Content and it should be 400kg/m^3 - 600kg/m^3.

Example: A SCC mix powder content of 550 kg/m3 is taken by fixing 0.36 water/binder ratio by weight with 35% coarse aggregate content of concrete volume. Cement has been replaced in two ways, the first way is replaced with 30% fly ash (Class F) and other way is fly ash blended with rice husk ash, in 30% fly ash replacement of 5 10%, 15%, 20% and 25% of rice husk ash by percentage weight of total powder content. The coarse aggregates are used with 60:40 blending by percentage weight of total aggregate. In this different mixes with coarse aggregate of sizes 10mm and 12.5mm are used. New generation superplasticizer used. 2% of air content is fixed by volume of concrete.

Following are the two combinations of mixes studied:

a) Self-compacting concrete with fly ash

- M1 – 70%OPC + 30% FA

b) Combination of fly ash and rice husk ash based self-compacting concrete

- M2 – 70%OPC + 25%FA + 5%RHA
- M3 – 70%OPC + 20%FA + 10%RHA
- M4 – 70%OPC + 15%FA + 15%RHA
- M5 – 70%OPC + 10% FA + 20%RHA
- M6 – 70%OPC + 5%FA + 25%RHA

2.1 CALCULATION OF MATERIALS FOR M3

- M3 – 70%OPC + 20%FA + 10%RHA

A. Calculation of Coarse aggregate

- Blending : 60:40
- Specific gravity : 2.66
- Dry-rodded unit weight : 1620 kg/m^3
- % of Coarse aggregate in DRUW : 50
- Coarse aggregate weight :

  1620*(50/100) = 810kg/m^3
- Coarse aggregate volume :

  [(810*(60/100))/2.66] + [(810*(40/100))/2.66] = 304.52m^3 or 30%

B. Mortar volume:

- Mortar Volume : (Volume of concrete- Volume of CA)
  = 1000-304.52 = 695.48 m^3

C. Fine aggregate volume:

- % of FA in Mortar volume : 45
- FA Volume : 695.48 *(45/100) = 312.96 m^3

D. Paste volume:

- Paste Volume : Volume of mortar – Volume of FA
  = 695.48-312.96
  = 382.52 m^3

E. Determination of paste composition

Specific gravity } OPC : 3.15; FA : 2.20; RHA : 2.13

- Air content : 2%
- Ratio of Water/ binder (by weight) : 0.36
- % of FA } by weight of binder 20
- % of RHA } by weight of binder 10
- % of SP } by weight of binder 0.9
- **Binder : 550 kg/m^3**
- Fly ash : 550*(20/100) **= 110**
- RHA : 550*(10/100) **= 55 kg/m^3**
- Cement : 533-(110+55) **= 385**
- Water : 550*0.36 **= 198 litre**
- Volume of cement : 385/3.15**=122.22 m^3**
- Volume of FA : 110/2.20 **=50**
- Volume of RHA : 55/2.13 **=25.82 litre/m^3**
- SP : 12222*(0.9/100) **= 1.09 kg/m^3**
- Total Volume of Paste
  =Volume of cement + Volume of FA + Volume of RHA + SP + Air + Water
  = 122.22+50+25.82+198+1.09+2*10
  = 417.04 m^3

F. Calculation of materials for concrete

- Specific gravity of FA : 2.6
- Percentage of Water absorption } 20mm : 0.3; 10 mm : 0.3; FA : 1.0
- Percentage of Moisture } 20mm : 0.0; 10mm : 0.0; FA : 0.0
- Cement : 385 kg/m^3
- Rice husk ash : 55 kg/m^3
- Initial water content : 198 litre
- Coarse aggregate : 810 kg/m^3
- 12.5mm coarse aggregate (CA-I) : 810*(60/100)
  = 486 kg/m^3
- 10mm coarse aggregate (CA-II) : 810*(40/100)
  = 324 kg/m^3
- Sand : 312.96*2.6
  = 814 kg/m^3

G. Materials Required:

- M3 – 70%OPC + 20%FA + 10%RHA

- Cement : **385 kg/m^3**
- Fly ash :**110 kg/m^3**
- Rice husk ash : **55 kg/m^3**
- Initial water content : **198 litre**
- Coarse aggregate : **810 kg/m^3**
- 12.5mm coarse aggregate (CA-I) : **486 kg/m^3**
- 10mm coarse aggregate (CA-II) : **324 kg/m^3**
- Sand (FA) : **814 kg/m^3**
- SP :**1.00 kg/m^3**

Mix Proportion of Ingredients

MIX	BINDER	CEMENT	FA	RHA	WATER (litres)	12.5 mm	10 mm	FA	SP
	kg/m^3					kg/m^3			
M3	550	385	110	55	198	486	324	814	1.0

3. CONCLUSIONS

Now a day's it is vital to produce Self-Compacting Concrete in the civil engineering field. Self-Compacting Concrete produces large benefits and advantages over normal or regular concrete like, Labor reduction, Accelerates project work, Superior strength and Durability and Produces good surface finish etc…

To achieve the above properties of Self-Compacting Concrete it requires a proper mix proportion. This can be resulted by making many trail mixes. This trail mixes is produced by proper mix design.

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